

# Future Prospects for sub-meV Spectroscopy

Harald Sinn, Sector 30

Readers may view, browse, and/or download material for temporary copying purposes only, provided these uses are for noncommercial personal purposes. Except as provided by law, this material may not be further reproduced, distributed, transmitted, modified, adapted, performed, displayed, published, or sold in whole or in part, without prior written permission from the publisher.

# APS upgrade planning meeting: sub-meV, July 20, 2006

## Organizers:

Wolfgang Sturhahn

Yuri Shvydko

Tom Toellner

Harald Sinn

## Additional participants:

Steve Cramer

Bob Scheidt

Steve Durbin

Alexander Kolesnikov

Sector 3, 9 and 30

Further contributions: Tim Sage,  
Takeshi Egami, Gopal Shenoy, ...

# APS upgrade: meV Spectroscopy

- longer straight sections (7 to 11 m)
- superconducting short period undulators
- 200 mA

× 2



× 2



× 2



10

(timing important for nuclear resonant technique!)

- reduced emittance

→ better focusing

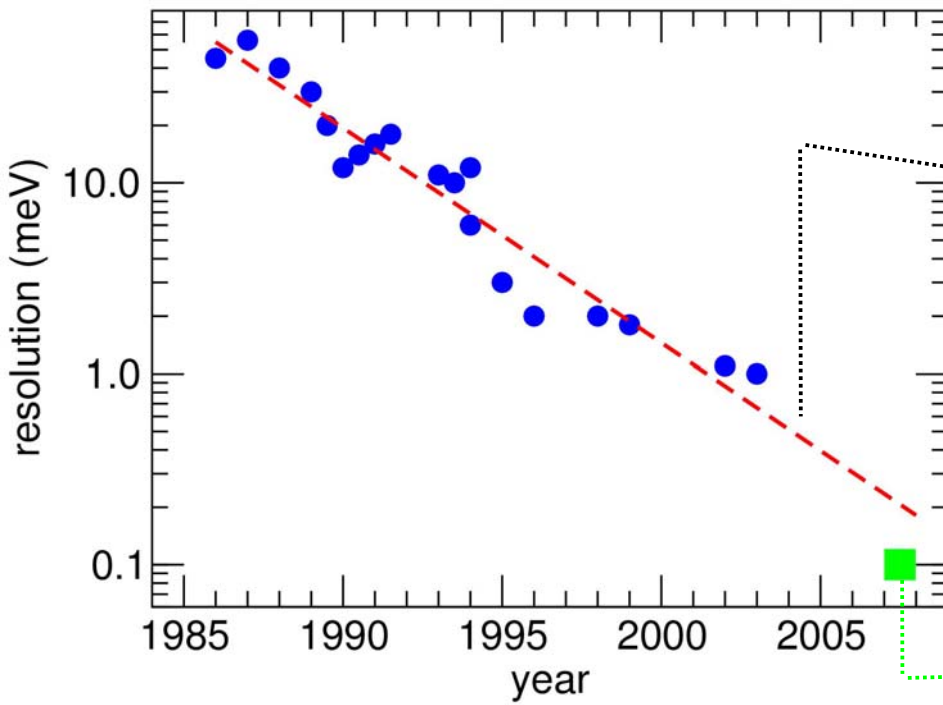
→ 'easier'  
monochromators

ERL option: > factor 10, sub- $\mu\text{m}$  focus

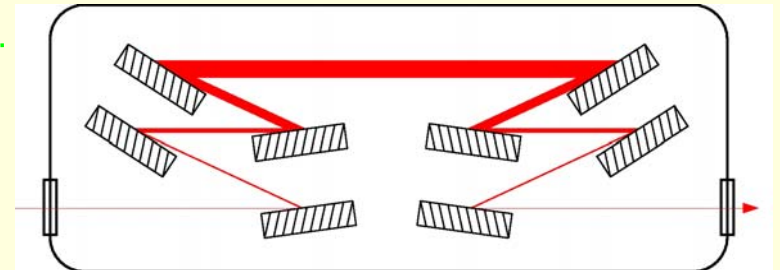


# IXS resolution in the synchrotron radiation age

after E. Burkel, *Rep.Prog.Phys.* **63** (2000), modified



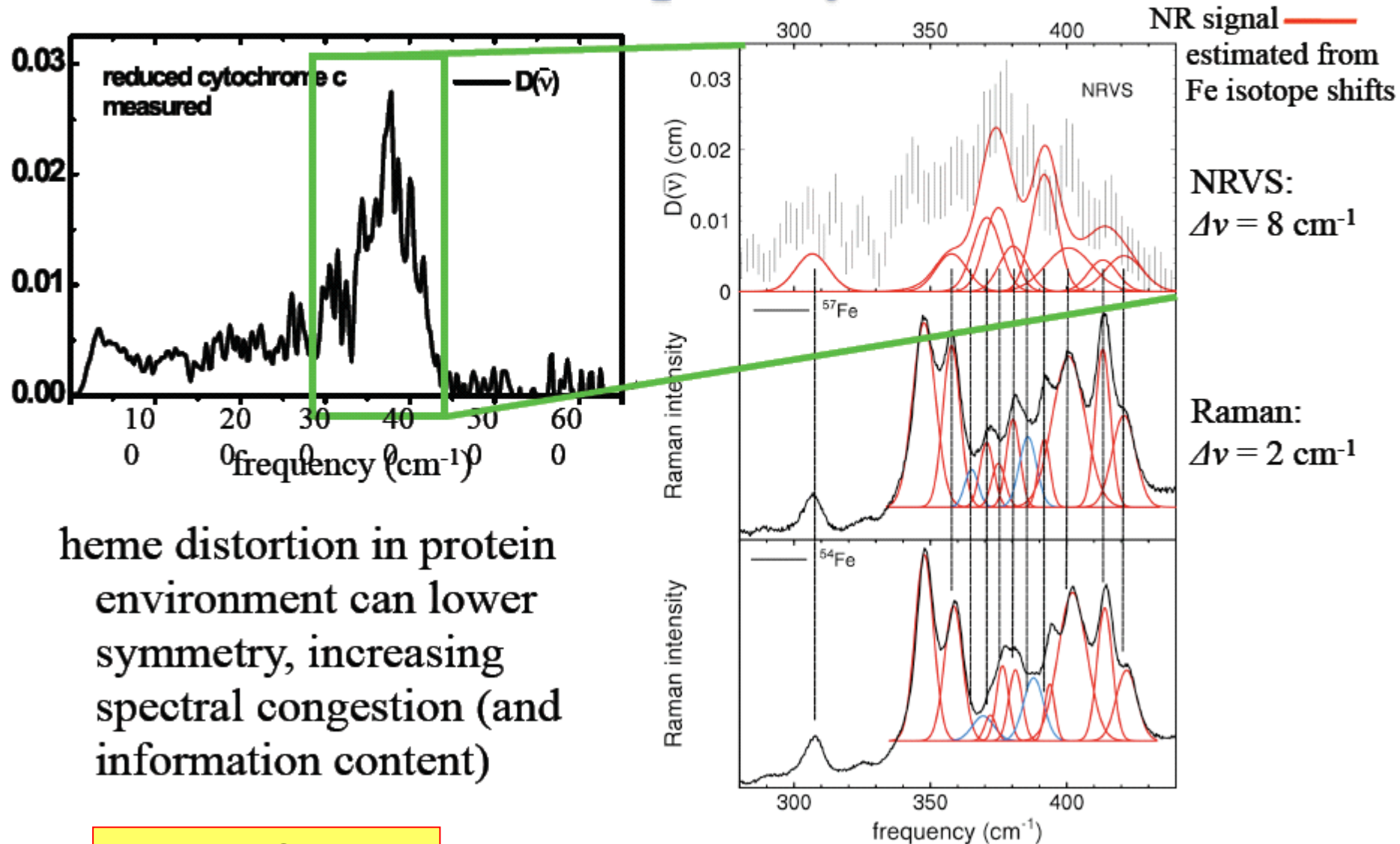
first cryogenic high-resolution monochromator  
*T.S. Toellner et al., J. Synchrotron Rad.* **13** (2006) 211



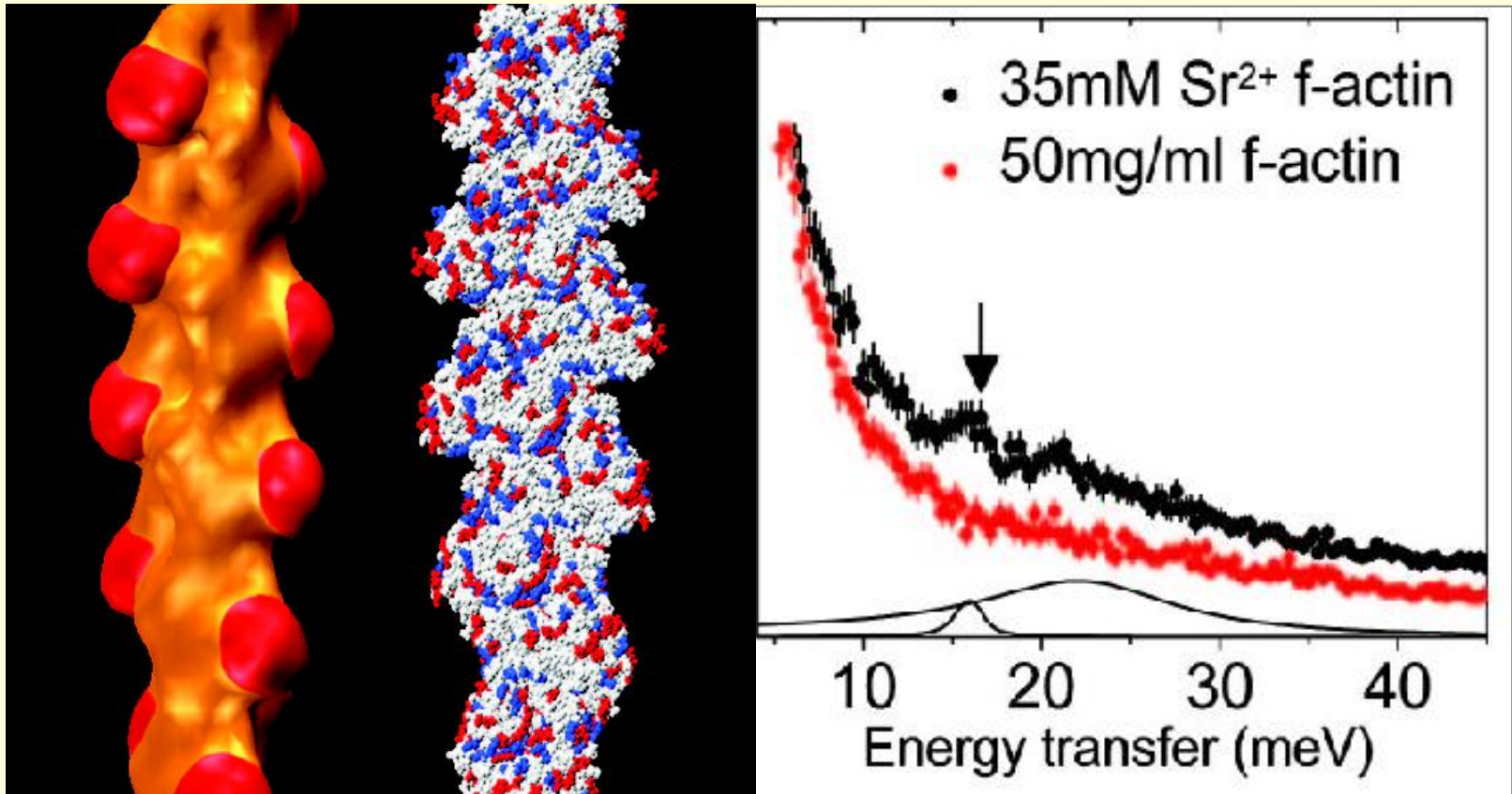
# Science with sub-meV

- 1.) IXS: resolve excitations in bio-polymers (membranes) and nanostructures (10-20 Å)
- 2.) IXS: High Pressure Phonons: better separation of elastic line, viscosity of geo-physical liquids
- 3.) NRS: resolve more complex spectra from proteins
- 4.) NRS: access longer time scales, e.g. protein conformational dynamics
- 5.) meV electron-emission-spectroscopy will be possible
- 6.) sub- $\mu\text{m}$  focus: phonons at grain boundaries! (Gopal)

# Energy resolution and spectral complexity

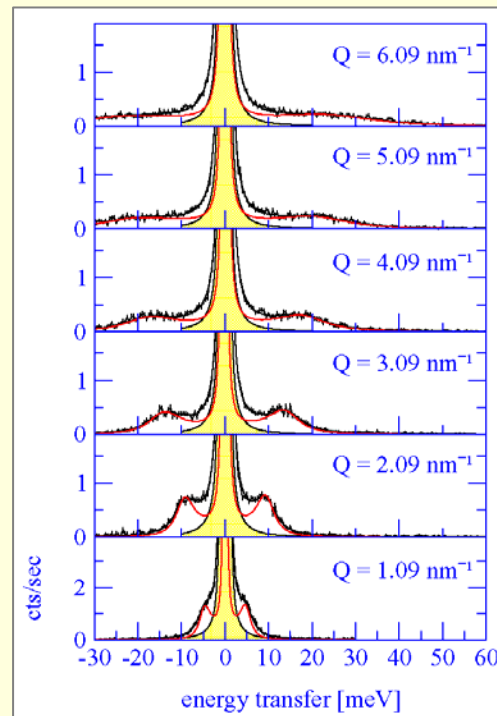


# IXS: Excitations in Bio-Polymers

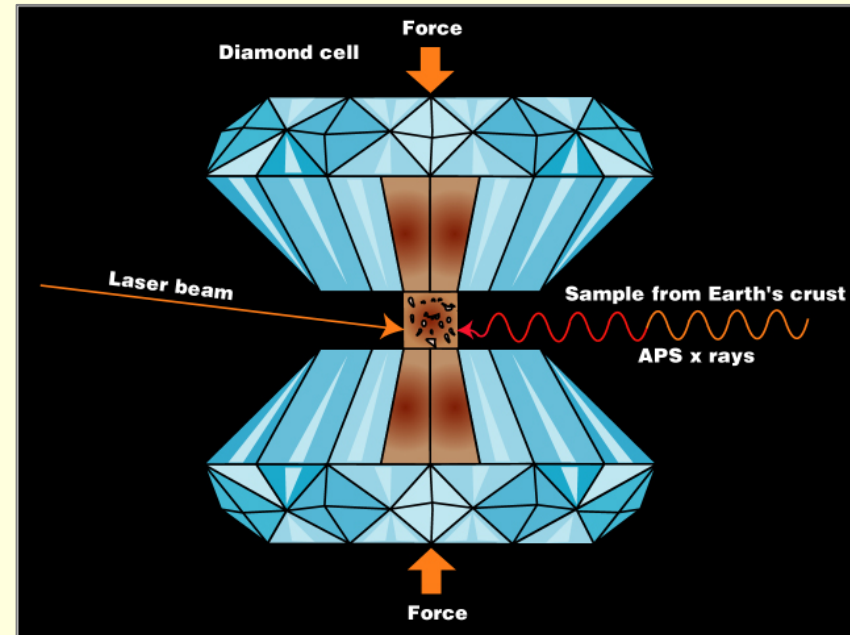


Gerard Wong et al. UIUC: T. Angelini et al. PNAS USA 103, 7962-7967 (2006)

# IXS: High Pressure Phonons in Liquids: Viscosity!



From H. Sinn et al. Science 299, 2047 (2003). Reprinted with permission from AAAS.

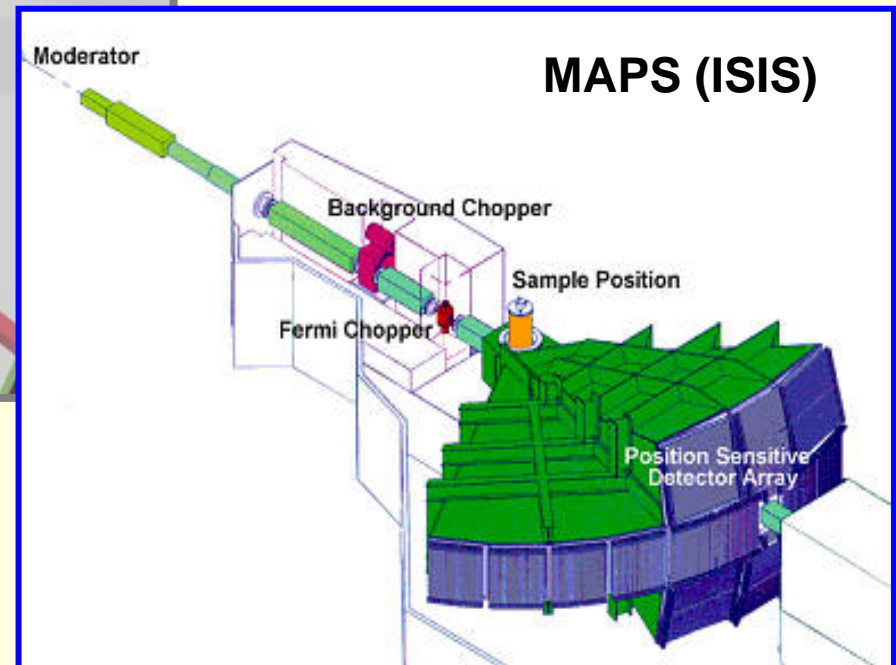
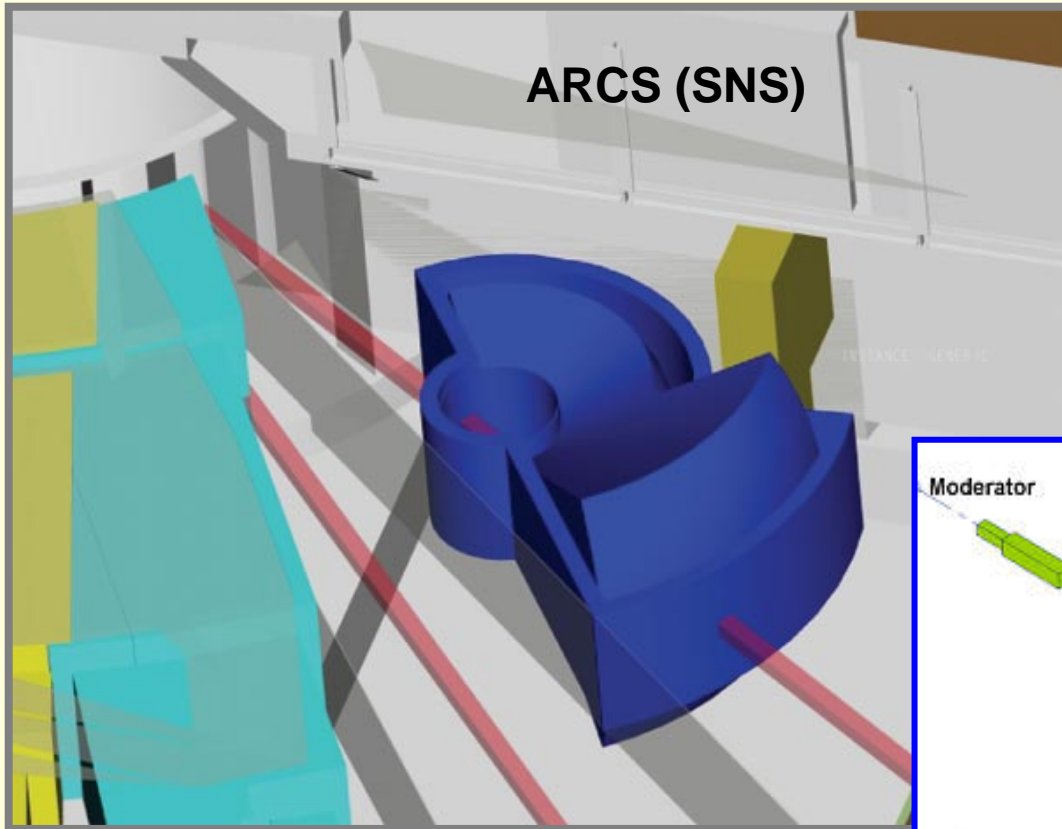


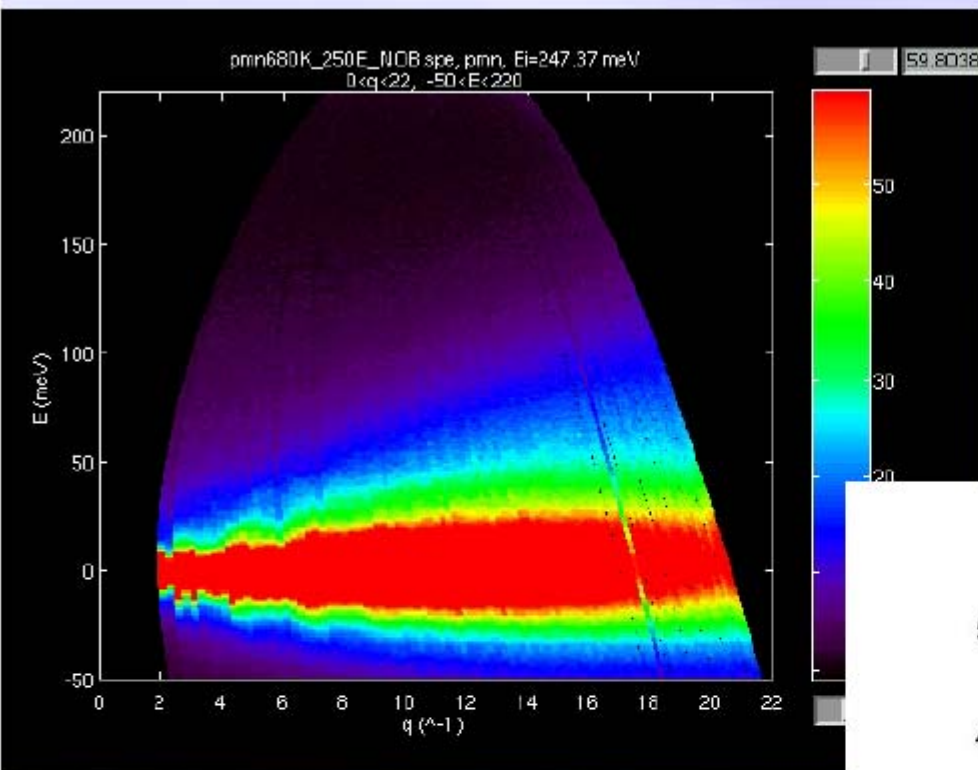
**Sector 3: Alatas, Zhao et al.**

# HERIX today at Sector 30



# Neutron spectrometers today

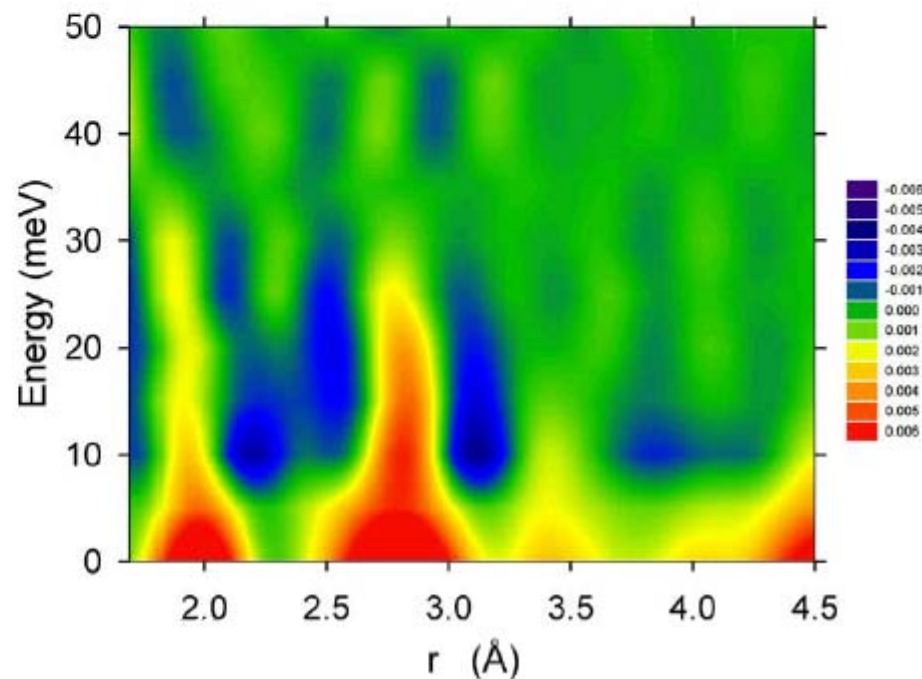




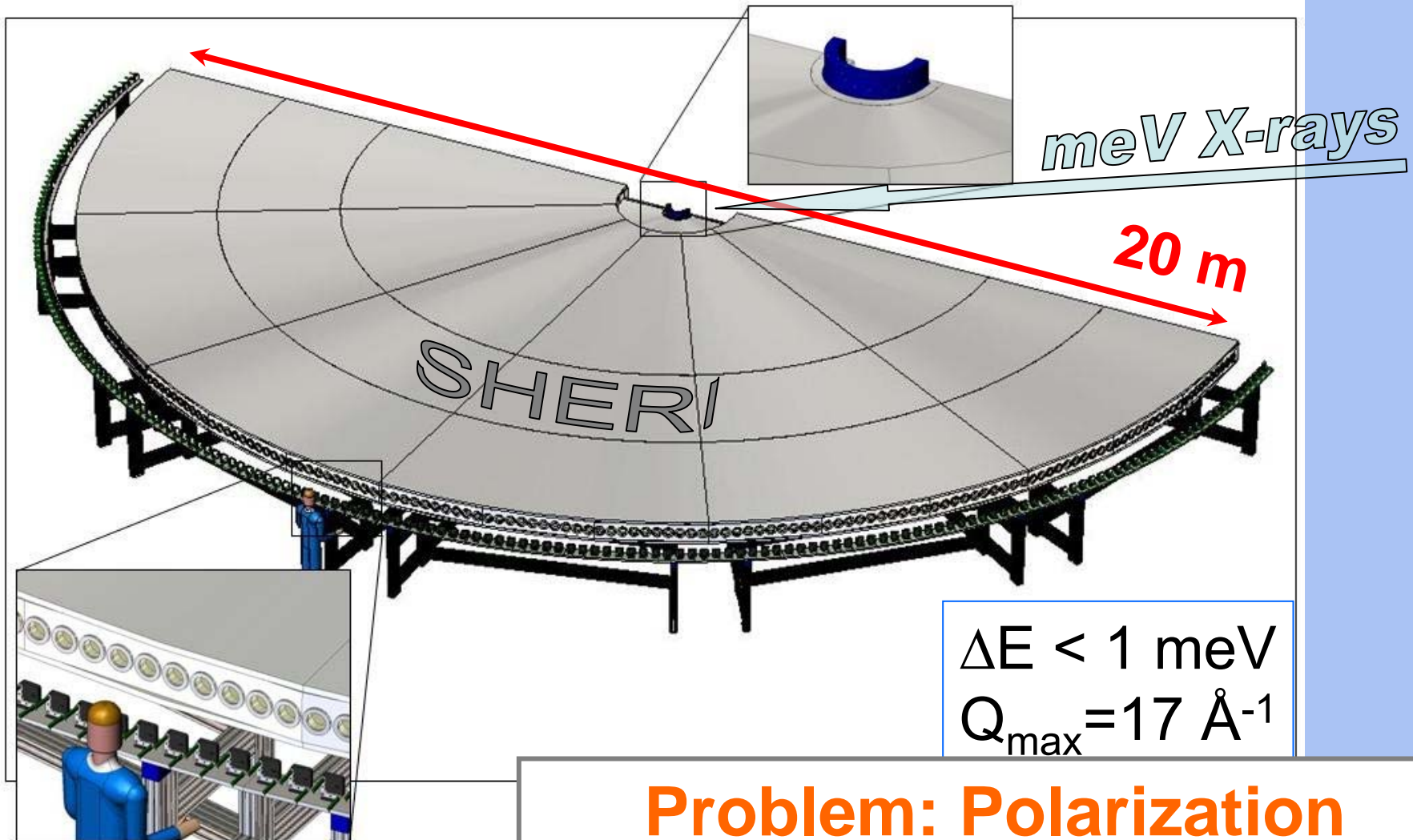
**Dynamic pair  
distribution function**

**Takeshi Egami: APS  
colloquium Feb 2006**

Fourier-transform from  
Q space to real space



Ercan's dream machine:  
SHERI : Super High Energy Resolution Instrument  
0.6 meV @ 25.7 keV



**Problem: Polarization  
penalty in horizontal plane!**

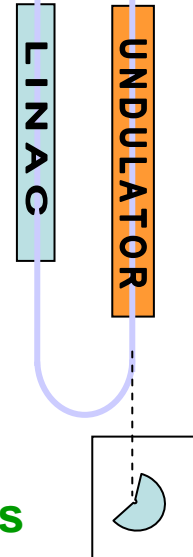
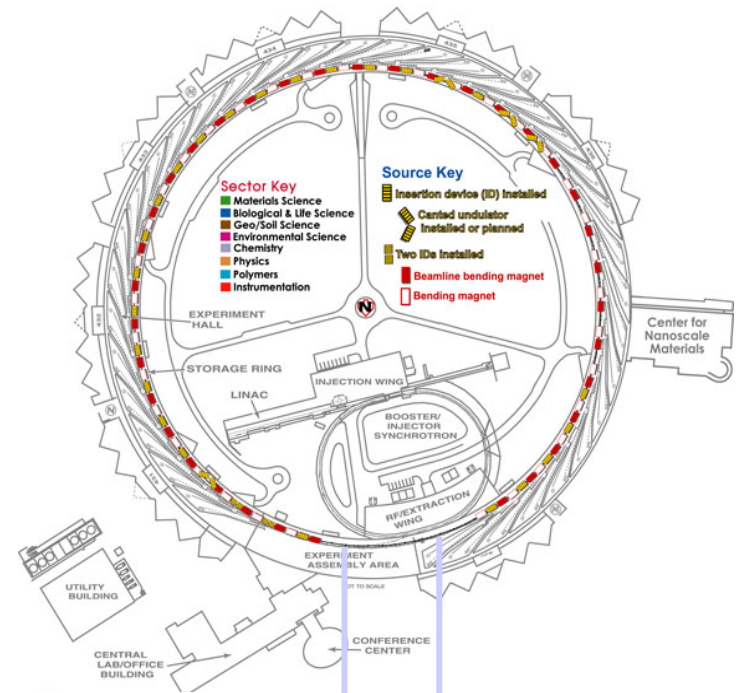
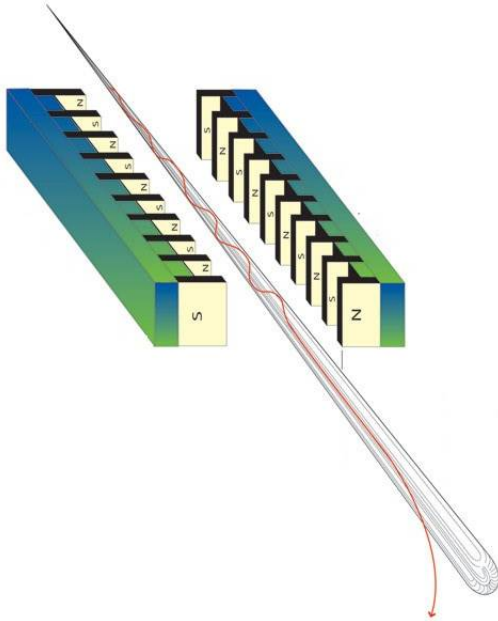
# APS 2012

**SHERI ?**



# 2015: APS-ERL!

## Horizontal Undulator



IXS spectrometers